A Novel Distal Biceps Rupture Repair Technique Utilizing a Biocomposite Scaffold

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ABSTRACT

Distal biceps tendon ruptures are uncommon injuries that have a re-rupture rate of 1.2% - 6%. In severe traumatic injuries or chronic injuries, a distal biceps tendon repair may require augmentation due to insufficient tissue quality. Unsuccessful treatment of these injuries can result in the loss of approximately 40% of supination strength and 30% of elbow flexion strength. There has been a growing interest in biologic augmentation in orthopedic surgery, and its incorporation into distal biceps tendon repairs has increased as well. Established bio-inductive implants and dermal allografts have been shown to be of benefit; however, these biologics have drawbacks such as failure to incorporate at time of implantation, lack of structural strength, and technical difficulty of implantation. The BioBrace® (ConMed, New Haven, CT) is a bio-inductive, biocomposite scaffold that is composed of highly porous type I collagen and bio-resorbable poly (L-Lactide) (PLLA) microfilaments. It can be used in conjunction with distal biceps tendon repair or reconstruction. It has the advantage of providing strength to the augmented repair at time zero of implantation, while also demonstrating the ability to induce new organized tissue growth throughout its resorptive phase. We describe a technique to successfully augment a distal biceps tendon repair using the BioBrace®.

INTRODUCTION

Distal biceps ruptures are relatively uncommon injuries with an incidence of 1.2 to 2.55 per 100,000 patients; they account for approximately 3% of all biceps ruptures.[1,2] More than 90% of patients who sustain these injuries are male and they typically occur in the setting of an eccentric load with a flexed elbow.[3] Such injuries cause a significant loss of supination and flexion strength in the extremity. Prokuski et al. reported a loss of 40% in supination strength and 30% in elbow flexion strength when injuries were treated non-operatively.[2]

Surgical treatment for distal biceps ruptures is well-established in the literature and provides an excellent return of strength function at the elbow joint compared to conservative treatment. In some cases, tear patterns of the distal biceps occur that may require adjuvant surgical intervention due to poor tissue quality or shortening of the distal biceps tendon stump. In such cases, the distal biceps may be sutured into the biceps brachii to maximize flexion strength or allograft augmentation may be required. Nevertheless, re-rupture rates after primary repair have been reported to be between 1.2% and 6%.[2] Repairs are typically performed via one or two incisions and different methods include the use of bone tunnels, suture anchors, cortical buttons, and/or interference screws.[1] While postoperative rehabilitation protocols vary widely, a period of immobilization at 110° of elbow flexion is generally recommended to allow for healing.

Recently, there has been growing interest in the use of biologic and synthetic implants for augmentation of tendon repairs and reconstructions. The proposed benefits of augments include improved healing, load sharing, and additional construct strength at time zero.[4,5] Within the rotator cuff literature, the mostly widely used biologic augments are a type I bovine collagen bio-inductive implant and dermal allografts. While these grafts offer some benefits, they also have some drawbacks, including a lack of structural strength, delayed incorporation of the graft, and technical difficulty of implantation.[6]

Despite the growing interest in tendon and ligament augmentation, there is little information in the literature regarding the distal biceps. Conroy et al. performed a biomechanical study in which a dermal allograft was used to augment a thinned or atrophic distal biceps tendon. Addition of the allograft increased the load to failure and stiffness compared to tendons that were not augmented with a graft.[7] This suggests that augmentation may play a role in improving the mechanics of a distal biceps repair and restoring the strength back to that of native tendon.

The BioBrace® (ConMed, New Haven, CT) is a bio-inductive, biocomposite scaffold composed of highly porous type I collagen and bio-resorbable (L-lactide) (PLLA) microfilaments. The scaffold is unique because its open pore biocomposite design allows it to provide both strength and biology to the repair construct, unlike other implants on the market. Its high porosity allows for rapid cellular infiltration and encourages the induction, maturation, and remodeling of host tissue. Furthermore, BioBrace® reinforces host tissue at time zero of implantation with load sharing strength of 141 N.[7] It maintains strength for up to 24 months to fully support the healing process and is then resorbed, mitigating the concerns associated with a permanent material. The purpose of this article is to propose a reproducible technique for the implantation of the BioBrace® biocomposite scaffold to augment a distal biceps repair.

SURGICAL TECHNIQUE

Surgical Indication

In the senior author's practice (SM), complete distal biceps ruptures are treated to prevent loss of strength of supination and flexion. Patients with partial tears are repaired or reconstructed if conservative management fails. In the setting of massively retracted tears or poor tissue quality, we have traditionally augmented these repairs with hamstring allograft, and more recently, with biocomposite scaffolds. Contraindications to surgical management include active infection, low functional demand, or limited passive range of motion in flexion or extension.

In our case presentation, the patient is a 26-year-old professional MMA fighter who suffered a traumatic dominant arm distal biceps tendon rupture. Pre-operative imaging noted a mid-tendon tear of the biceps with approximately 1.5 cm of tendon left on the radial tuberosity. The remaining tendon was noted to be retracted proximally by 6 cm. An acute on chronic component was noted on MRI. Intraoperatively, the torn tendon was noted to be of poor tissue quality and measured approximately 5 mm in diameter (Fig. 1). Based on this criterion, the use of a biocomposite scaffold was indicated by the lead author.

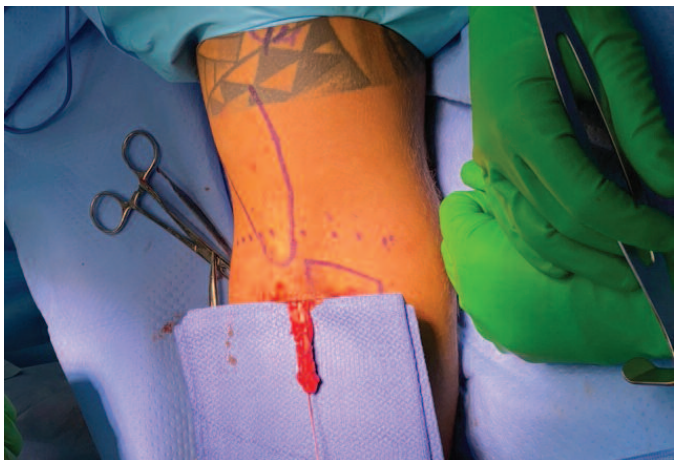

Figure 1. The distal biceps tendon tear has been identified and sized at 5 mm in diameter. The tissue quality during preparation was noted to be poor.

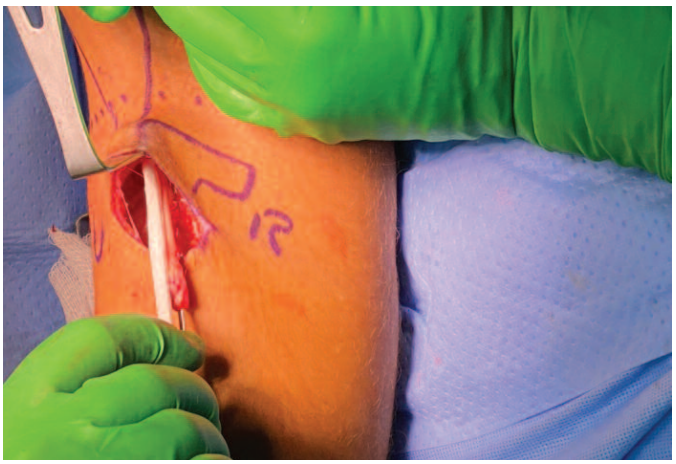

Figure 2. The Biobrace™ (blue arrow; ConMed, New Haven, CT, USA) is placed adjacent to the native tendon for fixation purposes. The post proximal end of the scaffold is overlaid on the distal muscle for incorporation purposes.

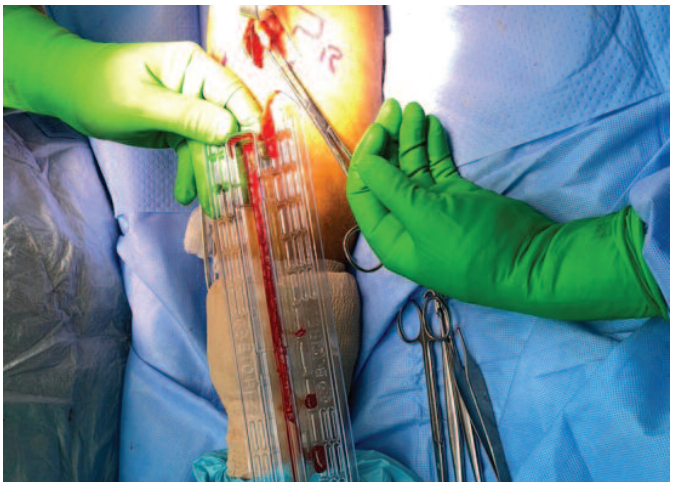

Figure 3. The Biobrace™ is rehydrated within its packaging using the patient's whole blood prior to implantation to increase biologic healing potential.

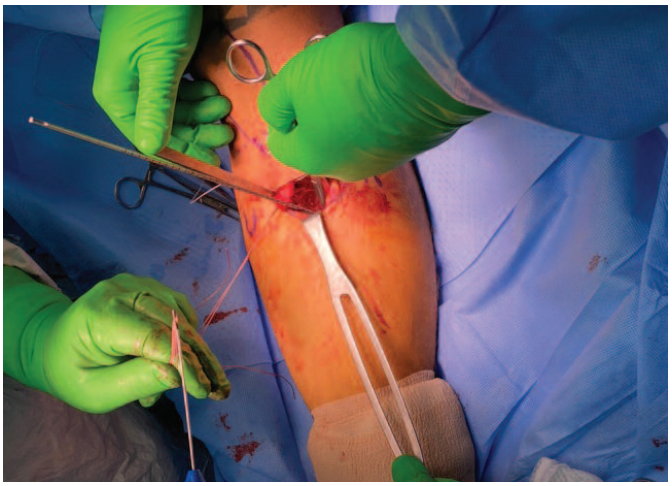

Figure 4. A spade tip drill pin is placed bi-cortically into the radial tuberosity and maintained for over-reaming a socket using an acorn reamer.

Patient Positioning

After induction of general anesthesia, the patient is kept supine on the operating room table. Using a hand table, a tourniquet is placed on the proximal arm while keeping in mind that the surgical site will be centered around the antecubital fossa. The operative extremity is prepared and draped in a standard fashion for routine surgery at the elbow. Fluoroscopy is maneuvered towards the distal aspect of the hand table. The lead surgeon-author prefers to mark out the radius and specifically the radial tuberosity prior to incision for anatomic reference intraoperatively. This is performed under the assistance of fluoroscopy.

Surgical Dissection and Bicep Tendon Preparation

A transverse single incision approximately 5 to 6 cm in length is made, centered over the radial tuberosity. The skin is carefully dissected to develop a plane to the biceps tendon stump, while being mindful of pertinent neurovascular structures such as the lateral antebrachial cutaneous nerve and cephalic vein. Often, an Army-Navy retractor is used for better visualization proximally due to the biceps stump retraction. Once the tendon stump is identified, adhesions and scar tissue are released to properly mobilize the tendon. The tendon may be placed on a tongue blade to properly debride the surrounding area with a knife or scissors. After debridement, tissue quality may be noted.

Preparation of the BioBrace® Biocomposite Scaffold

The biocomposite scaffold is prepared after the native tendon has been identified and prepared. The scaffold is placed adjacent to the distal biceps tendon to determine the desired size and length (Fig. 2). The BioBrace® comes pre-packaged as a 5mm X 250mm length implant that can be trimmed to accommodate the tendon needs. The lead author will either augment the tendon in a side-to-side fashion or by having the scaffold doubled over the native tendon, depending on the amount of native tendon deficiency. The BioBrace® is then hydrated in autologous blood or sterile saline (Fig. 3). The BioBrace® is incorporated into the tendon with a whipstitch using a #2 non-absorbable suture. The locking stitch extends approximately 4 cm above the distal biceps stump.

Graft Site Preparation

Dissection down to the radial tuberosity is performed with care to avoid nearby vasculature and neuroanatomy. A Hohmann retractor is placed while being mindful of the posterior interosseous nerve (PIN). This is used for visualization of the tuberosity and to protect the nerve. The footprint of the biceps tendon on the radial tuberosity should be completely exposed to ensure proper repair; this can be achieved through maximal supination of the forearm. The mobility and length of the biceps tendon are inspected by placing an Allis clamp on the tendon and confirming that it is able to reach the radial tuberosity. Fluoroscopy is then used to confirm the starting point on the radial tuberosity for tendon fixation. The lead surgeon-author prefers to dunk the tendon into a socket and secure it via bi-cortical button fixation. A spade tip guide pin is drilled bi-cortically after confirming the starting point (Fig. 4). An 8mm reamer is used to create a uni-cortical socket. The surgical site is irrigated to remove any excess bone to minimize heterotopic ossification. Following this, the augmented biceps tendon is affixed to a button fixation device and delivered into the socket. After the button is flipped on the second cortex, fluoroscopy is used to confirm placement. One limb of the suture that had been incorporated through the button is passed back through the biceps tendon and tied. An optional PEEK tenodesis screw can be placed into the socket if desired to increase tendon fixation. Final tendon evaluation is undertaken prior to closure, noting that the tendon is appropriately tensioned (Fig. 5).

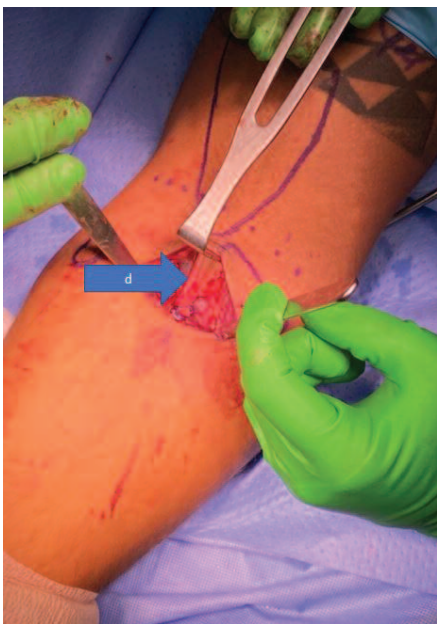

Figure 5. The final bio-composite (blue arrow) augmented tendon repair is evaluated prior to closure.

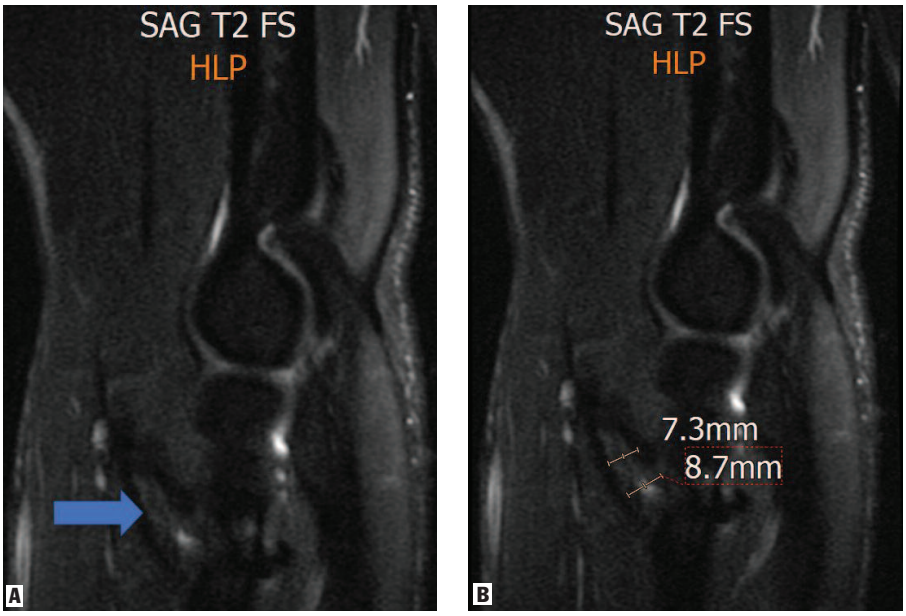

Figure 6 A and 6B. Coronal MRI images 1 year post bio-composited augmented distal biceps tendon repair demonstrate homogeneous appearance of tissue quality with a tendon diameter of 8 mm.

DISCUSSION

Many treatment algorithms exist for treatment of distal biceps ruptures based on the acuity of the injury and the quality of the tendon. With the rise of biologic and synthetic augments, how we treat distal biceps ruptures that are at risk of re-rupture has changed. The literature regarding the causes of re-rupture is sparse, partially due to the low incidence of this injury. Re-rupture rates have been reported to comprise 1.2% to 6% of all cases.[2] Cohen evaluated the causes of re-rupture and stated that it may be due to inadequate initial attachment, patient noncompliance in the early postoperative period, or excessive tension on the repair.[8] The use of a bio-inductive scaffold (BioBrace®) can optimize healing potential by providing both biology and strength to the repair.[9] Cheesman et al. found that it could be applied to rotator cuff tears that exhibit poor tissue quality, which is often seen in large to massive rotator cuff tears.[5] The use of this novel bio-inductive scaffold to augment distal biceps ruptures is attractive given its combined strength and healing properties. BioBrace® is 80% porous, which allows for rapid cellular infiltration and soft tissue ingrowth. It is rapidly incorporated into the host tissue and, as it resorbs, it leaves behind new native tissue with regularly oriented connective tissue fibers. Furthermore, BioBrace® has been shown to increase tendon thickness within 6 weeks, which would decrease the likelihood of re-tears. The bio-inductive scaffold provides load-sharing strength at time zero of implantation, which may help mitigate the risk of re-rupture during the early post-operative period. The advantage of BioBrace® is its ability to improve healing and provide strength; no other soft tissue augmentation implant offers this combination of benefits. MRI follow-up at 1 year has demonstrated restoration of the native biceps tendon and showed an increase in tendon diameter from 5mm at pre-operative evaluation to 8mm (Figs. 6A & 6B). The authors believe the BioBrace® has potential for wide applicability in cases of distal biceps rupture. It can be used in conjunction with good-quality tendon to augment a repair or in addition to an allograft when reconstruction is needed.

CONCLUSION

The use of a biocomposite scaffold for distal biceps tendon repairs has the potential to enhance distal biceps tendon repairs through load-sharing and increased biologic incorporation. This may be especially desirable in cases of poor quality tissue. The biocomposite scaffold could also be used alongside an allograft for distal biceps tendon reconstruction to improve allograft incorporation and overall healing, or as a stand-alone augment.

We have described our surgical approach to repairing a distal biceps rupture using a novel biocomposite scaffold as an augmentation for insufficient tissue. Additional studies are needed to survey the re-rupture rate with the use of this scaffold in distal biceps tendon repairs. However, given the low incidence of these injuries, such data collection may prove challenging. Nevertheless, outcomes should be collected to confirm the reproducibility of this technique as well as its success in treating this injury. Early results on tendon repair and reconstruction using the BioBrace® in more commonly affected areas, such as rotator cuff repairs, are promising, and suggest that such success can be extrapolated to its use in distal biceps repair. We believe that use of the BioBrace® is a viable option for the treatment of distal biceps ruptures of acute or chronic etiology. STI

AUTHORS' DISCLOSURES

SM is a consultant for ConMed (New Haven, CT, USA). DL declares that there are no conflicts of interest.

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